Targeted Health Department Expenditures Benefit Birth Outcomes at the County Level

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Background: Public health leaders lack evidence for making decisions about the optimal allocation of resources across local health department (LHD) services, even as limited funding has forced cuts to public health services while local needs grow. A lack of data has also limited examination of the outcomes of targeted LHD investments in specific service areas.

Purpose: This study used unique, detailed LHD expenditure data gathered from state health departments to examine the influence of maternal and child health (MCH) service investments by LHDs on health outcomes.

Methods: A multivariate panel time-series design was used in 2013 to estimate ecologic relationships between 2000−2010 LHD expenditures on MCH and county-level rates of low birth weight and infant mortality. The unit of analysis was 102 LHD jurisdictions in Washington and Florida.

Results: Results indicate that LHD expenditures on MCH services have a beneficial relationship with county-level low birth weight rates, particularly in counties with high concentrations of poverty. This relationship is stronger for more targeted expenditure categories, with expenditures in each of the three specific examined MCH service areas demonstrating the strongest effects.

Conclusions: Findings indicate that specific LHD investments in MCH have an important effect on related health outcomes for populations in poverty and likely help reduce the costly burden of poor birth outcomes for families and communities. These findings underscore the importance of monitoring the impact of these evolving investments and ensuring that targeted, beneficial investments are not lost but expanded upon across care delivery systems.
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Introduction

A major area of policy interest among public health leaders and health system planners is determining return on investment, or health benefits, in prevention and treatment activities carried out by local health departments (LHDs).[1] National philosophic shifts in public health practice away from individual-oriented clinical services and toward population-level interventions, and the nation's economic recession, have changed local public health practice dramatically in the last decade.[2–5]

Maternal and child health (MCH) services are one area of LHD services that has undergone major changes.[2,3,6] MCH and other preventive services have often been reduced with little evidence-based guidance or measures of health impact on populations at risk.[7,8] This inadequate guidance has been due, in part, to a lack of data and evidence linking LHD investments in MCH services and health outcomes.[9,10]

In today's environment, states are preparing new primary care safety nets and other service changes mandated by the Patient Protection and Affordable Care Act. Advances in data and evidence about health effects of MCH and other LHD services are critical to inform practice and policy leaders about the design of these new systems and how to maximize existing system strengths.[11,12]

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MCH services provided by LHDs are prevention focused and traditionally have been a mix of services related to family planning (FP); nutritional support during pregnancy and in early infancy/childhood; and health education, screening, and referral for young mothers, children, and families at high risk.[2,3] Existing research indicates that certain services such as the education, screening, treatment, and contact tracing provided by LHD FP programs and other local agencies have helped reduce overall teenage pregnancy rates in the U.S.[13]

Similarly, research has linked the provision of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) as a service provided by LHDs and other community providers to early entry into and more adequate prenatal care for low-income pregnant women.[14–16] Prenatal care is emphasized in Healthy People 2010 and 2020[17] objectives as particularly important for improving birth outcomes and linking women to FP services and has been associated with reduced maternal and infant deaths.[18–20] Despite often not providing clinical prenatal care, LHDs provide critical linkages for women into community prenatal care services.[21]

LHDs and partner agencies in their jurisdictions (usually a county) often provide an array of maternal, infant, child, and adolescent support services that is more varied than FP and WIC, including health promotion activities such as home visiting programs and developmental screening.[2,3] LHDs tend to focus MCH services and related investments on populations at highest risk for poor birth outcomes.[22]

Many community factors, such as high rates of unemployment and poverty and low rates of high school completion, are determinants of poor birth outcomes and affect how LHDs and their partner agencies target their expenditures,[23,24] presumably generating a stronger effect on population-wide birth outcomes in areas with a high proportion of impoverished people. By targeting or prioritizing their services in favor of marginalized groups influenced by these social determinants, LHDs may increase the effectiveness of their MCH services and reduce community burden.

Morbidity and mortality associated with poor birth outcomes have a financial cost to society. Increases in morbidity related to low birth weight (LBW) contributes to high direct medical costs,[25–28] nonmedical costs such as higher child care expenses,[29] and less tangible costs such as the burden of caregiving to families.[30,31]

Recent studies using national data sets have identified linkages between general LHD spending and broad, distal mortality outcomes and related disparities.[32,33] Based on these studies and another[2] indicating that MCH-specific services provided by LHDs are linked to reductions in mortality disparities, the current study used unique, detailed data obtained through a two-state consortium of Public Health Practice-Based Research Network (PBRN) partners to examine impacts of MCH-related spending by LHDs on birth outcomes.

Methods

Study Design and Population

The authors examined local health jurisdictions in Florida and Washington using a multivariate panel time series to estimate ecologic relationships between 2000 and 2010 LHD expenditures on birth outcomes. The outcome measures examined were county-level rates of LBW, defined as weighing <2,500 g, and infant mortality rates (IMR), defined as death at age <1 year. These outcome data were obtained from Florida and Washington state department of health online databases.[34–37]

Three-year smoothed rates (2001/2002/2003−2008/2009/2010) were used for each outcome measure, except a 2-year smoothed rate (2009/2010) that represented the study's last time period, given the lack of 2011 data available during analysis. Outcomes were calculated as the sum of the indicator during each of the 3-year periods, divided by the sum of live births during that period, and multiplied by the appropriate scaling factor (100 for LBW and 1,000 for IMR).

Expenditure Measures

Annual LHD expenditure data, for which very few states have detail at the service-specific level, were obtained from PBRN practice partners in Washington and Florida. These data measured expenditures from 2000 to 2010 for all 102 LHDs in these states. Comparable expenditure variables were constructed depicting three service lines: annual WIC, FP, and maternal/infant/child/ adolescent health (MICA) expenditures by each LHD.[38]

MICA was formed as a composite of similar budget categories across the two states that represent comprehensive early intervention activities such as home visiting, group education, and preventive care clinic visits.[38,39] Per capita expenditure measures were inflation-adjusted to 2010 using the consumer price index and smoothed into 3-year averages. A 1-year time lag was included between expenditures and outcome measures.

Other Measures

Control variables included LHD-, community-, and health system-level factors identified in previous studies as having an apparent influence on population-level maternal and child health.[2,40] LHD-level factors included the existence of similar services available through an "alternative" service provider. "Alternative service" was measured using MCH-related survey questions from the two National Association of County and City Health Officials (NACCHO) Profile of LHDs Surveys carried out during the study period.[2,41,42]

Dichotomous variables measured the presence of WIC and FP alternative services, indicating provision of a similar service by another provider in either survey year 2005 or 2008. Alternative MICA service provision was depicted as a composite score (0−3)

generated from the three categories of services in the Profile Survey that were comparable to the services covered by the MICA expenditure variable (Table 1). A variable was also included indicating if an LHD's "top executive" was a clinician (nurse or physician) in either of the 2005 or 2008 NACCHO Profile Surveys.[38]

Socioeconomic characteristics of communities were captured using Robert and Reither's Socioeconomic Disadvantage Index.[2,41,43] This measure was constructed using a sum of Z scores representing median household income, percentage of households receiving public assistance, and percent county unemployment. The percentages of black residents, Hispanic residents, and residents completing at least high school were also included as covariates, as these factors also have unique relationships with maternal and child health.[23,40]

These sociodemographic data were obtained from the 2000 Decennial Census and from the 2010 American Community Survey (5-year estimates for 2006–2010). The numbers of per capita general practice and family medicine physicians in a jurisdiction were drawn from the Federal Area Resource File[44] and included as a measure of general community-level health care access and availability.[45] The percentage of county-wide, annual Medicaid-funded births and number of total births were also incorporated in the model, depicting local "need" or demand for LHD MCH services.[2,41]

LHDs were categorized as metropolitan (urban); micropolitan; or rural jurisdictions as indicated by the Federal Core-Based Statistical Areas (CBSA) data set.[46] Binary measures for each state provided control for potential state-level effects. Data were merged into an analytic file with LHD as the unit of analysis. All LHDs served either a single county (97.1%, n=99) or multi-county jurisdiction (2.9%, n=3).

Data Analysis

Data were analyzed in 2013 using Stata, version 13 (StataCorp LP, College Station TX). Models for both outcomes (LBW and IMR) and for each of five expenditure categories (WIC, FP, MICA, the three combined MCH categories, and total) were run separately and stratified by county-level poverty. Poverty stratification was structured using annual estimates of the percentage of residents aged 0–17 years in poverty and classifying the highest tertile for poverty in each state as "poor" and the remaining two tertiles as "non-poor." Analytic models used robust SEs, assuming cases were dependent within subjects and independent between subjects.

Six 1-year LHD observations were removed from Washington and 27 one-year Florida observations were removed owing to missing data or data incongruities. With incorporation of the smoothing design and time lag, the final sample included a 9-year time series with 885 observations from 102 LHDs in Florida and Washington.

Results

Compared to the nation as a whole, the 102 sample jurisdictions had similar median household incomes and unemployment rates in 2001–2005 and 2006–2010 (Table 1). Washington counties were well above the national average for percentage of residents who had completed high

school. Compared to all U.S. counties, Washington counties had particularly low percentages of black and Hispanic residents. Florida and Washington LHDs had similar percentages of jurisdictions with alternative FP providers as the nation. However, Florida had a much smaller percentage of LHDs with alternative WIC providers compared to LHDs nationwide and in Washington.

Nationally, the majority of LHDs had alternative providers in two of the MICA service categories, whereas the majority of the sample LHDs had three types of MICA alternative providers. Unemployment, the percentage of Medicaid funded births, and median household income increased between 2001–2005 and 2006–2010 nationally and for the counties in both states. The states particularly differed from each other in terms of public assistance, race/ethnicity, and education. Florida remained well below Washington and the national average percentage of households on public assistance by county.

Overall, total expenditures increased between 2000 and 2010, although Florida experienced an increase in expenditures during 2004–2006 followed by a slight decline, whereas Washington expenditures consistently increased (Figure 1). Florida LHDs had much higher average total annual expenditures than their Washington counterparts, and LHDs in poor Florida counties had higher total expenditures than the state as a whole; however, the reverse was true for Washington.

The MCH-related expenditures were more similar across the two states than total expenditures, but were consistently higher in Florida than Washington. LHD expenditures in the MCH combined and the MICA categories substantially decreased over time in Washington. FP expenditures in both Washington and Florida were consistently higher for the poor counties than the states' counties overall. This was also the case for MICA expenditures in Florida, but Washington's poor counties had lower MICA expenditures than the states' counties overall.

Rates of LBW and IMR were consistently lower in Washington jurisdictions than in Florida (Figure 2). Although Washington had consistently higher rates for these outcomes in poor jurisdictions, poor Florida counties showed little difference in outcomes compared to their non-poor counterparts. The 3-year smoothed rates of LBW and IMR nonetheless remained relatively flat; mean LBW increased from 7.6% to 7.8% and mean IMR decreased from 7.6 to 6.2 per 1,000 live births. The cross-sectional variation in these outcomes across jurisdictions, however, was much more pronounced.

Inferential analyses demonstrated significant associations between LHD expenditures and health outcomes (Table 2). Regression models showed that higher LHD expenditures at all levels were associated with fewer LBW births in the poorest tertile of LHDs in Washington. For

Table 1. Characteristics of the study sample relative to all U.S. counties and LHDs

Community Factors	All U.S. counties		Florida counties		Washington counties	
	2000−2005	2006−2010	2000−2005	2006−2010	2000−2005	2006−2010
Total population (n)	233,489,414	303,965,272	15,982,378	18,511,620	6,446,714	6,561,297
Median household income ($)	34,832	44,270	35,303	44,268	38,330	47,362
Households with public assistance (%)	3.6	2.5	2.8	1.5	3.8	3.7
Unemployed (%)	5.9	8.6	5.6	9.8	6.3	8.2
Black (%)	12.3	13.4	14.6	16.5	3.1	4.6
Hispanic (%)	13.7	15.7	16.8	21.6	7.3	10.5
Persons with high school or more education (%)	80.4	84.6	79.9	84.9	87.1	89.4
GP and FM physicians per 100,000 (2010)	30.1		21.6		40.2	
Medicaid funded births (%)	40.9	43.9[a]	39.8	47.7	44.8	47.9
CBSA (2005), % metro/micro/ rural	49.4/19.1/31.5		56.7/16.4/26.9		42.9/25.7/31.4	
LHD Factors	**All U.S. LHDs (n=2,725)**		**Florida LHDs (n=67)**		**Washington LHDs (n=35)**	
% (n) of LHDs with						
WIC alternative provider	47.0 (1,280)		19.7 (12)		48.6 (17)	
FP alternative provider	79.0 (2,152)		78.7 (48)		85.7 (30)	
1 MICA alternative provider	7.8 (213)		9.8 (6)		2.9 (1)	
2 MICA alternative providers	68.7 (1,873)		21.3 (13)		14.3 (5)	
3 MICA alternative providers	15.3 (417)		59.0 (36)		80 (28)	
Clinician executive (2005/ 2008), %	50.8/45.8		62.1/62.7		56.3/45.2	

[a]Missing 2010 data
CBSA, Core-Based Statistical Area; FM, family medicine; FP, family planning; GP, general practitioner; LHD, local health department; MICA, maternal, infant, child, and adolescent health; WIC, Women, Infants, and Children.

the non-stratified models with all sample jurisdictions, a significant negative relationship was found between LHD total, combined MCH, and MICA expenditures and LBW, but this finding was not robust at the state level.

When stratified by poverty, beneficial associations between each expenditure category and LBW were strongly apparent in Washington's poor jurisdictions but were not apparent in Florida or in the overall two-state sample of the high-poverty jurisdictions. All significant LBW findings also displayed the largest coefficients for the most targeted expenditures, with the largest effect observed for specific service expenditures, a smaller coefficient for combined MCH, and the smallest at the total expenditure level.

Significant associations were found between LHD expenditures and IMR in the total expenditure models for poor jurisdictions. Although the coefficients were small, the LHD total expenditure findings were consistent for the poor jurisdictions overall and for each individual state. This association between total expenditures and the entire sample of jurisdictions (non-stratified) was also borderline significant.

Discussion

To our knowledge, this is the first multi-state study to examine the impact of LHD expenditures for MCH services on birth outcomes, which demonstrated, to some extent, the relationship between spending and improved health outcomes. The strongest effect was seen in the sample's poor Washington jurisdictions and significant findings were not seen consistently in other study sample segments.

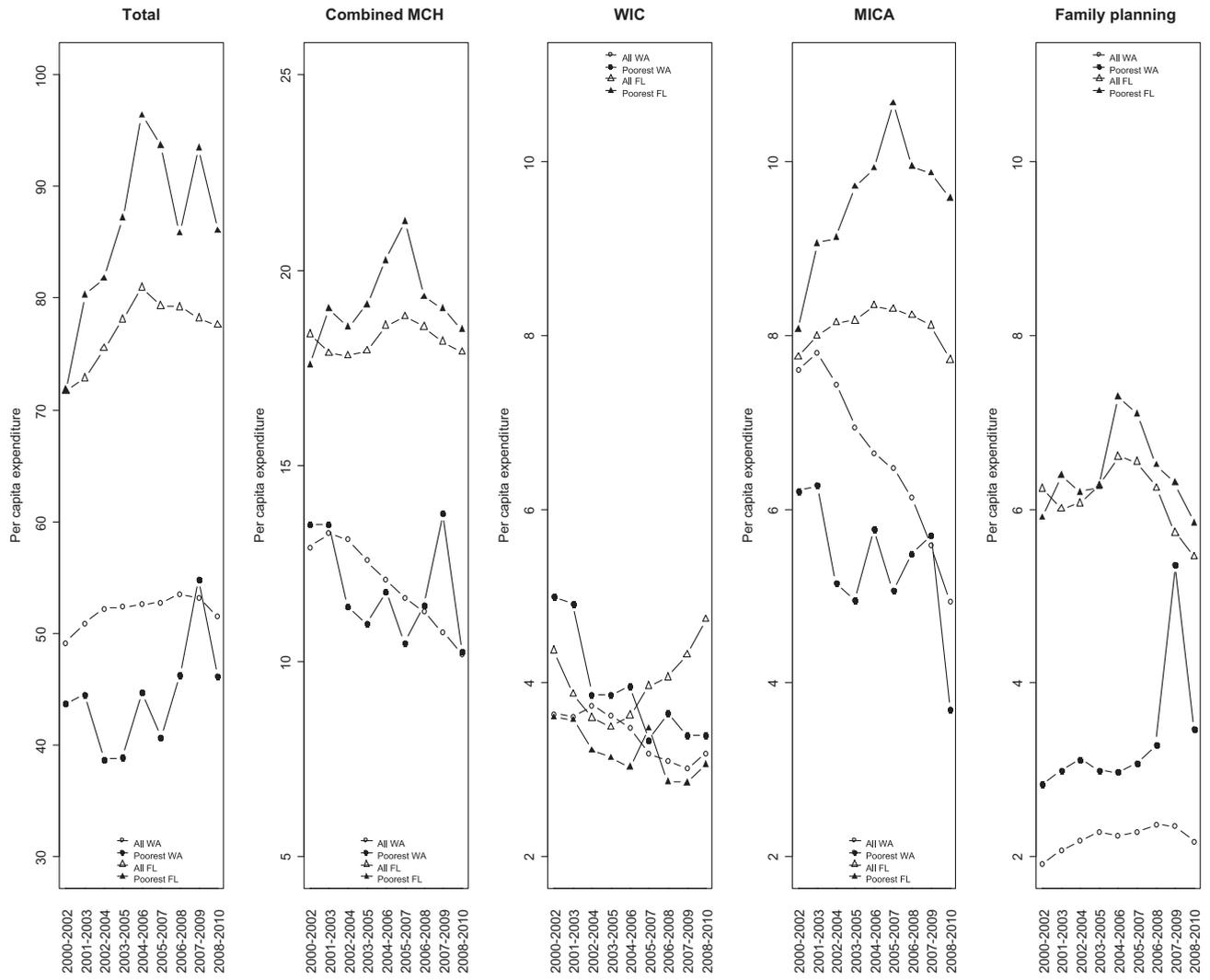LHDs typically focus their services and MCH investments on populations of highest need within their

Figure 1. Changes in inflation adjusted (to 2010) per capita LHD expenditures by 3-year smoothed averages
LHD, local health department

jurisdictions,[47] which is consistent with the finding of effects of MCH spending on LBW and IMR in high-poverty counties. The ability to detect effects in this study, however, may be diluted by other "noise" in the model, including counties with more advantaged populations that may not be targeted or affected by an LHD's MCH services.

Though effects on LBW were only found in Washington's poorest counties, the inability to detect an effect for Florida counties does not necessarily mean that there is none, as this noise may mask the association. This differentiation of effect relative to concentration of poverty suggests that MCH services provided by LHDs appear to impact populations differently or that LHDs are effectively targeting their services toward groups at risk.

The finding that more focused expenditures were associated with more proximal LBW outcomes, in contrast to the more distal IMR results, aligns with the

nature of LHD services. WIC, MICA, and FP services provide maternal support that might have direct effects on infant birth weight, such as WIC's focus on prenatal nutrition.[48] MICA services focus largely on prenatal and maternal support and health education,[39] and FP services facilitate birth spacing and early pregnancy detection.[49]

Infant mortality is a more distal health outcome than LBW, with more potential for influence from confounding factors. As such, IMR would understandably be associated with LHD total expenditures rather than MCH-specific expenditures, suggesting that it takes a wider "package" of preventive service investments to impact IMRs. LHD total investments, nonetheless, do have an apparent beneficial effect on IMR and particularly in communities with concentrated poverty. This comprehensive package might include community assessment and epidemiologic services (and their related expenditures) that would aid in the effective targeting of
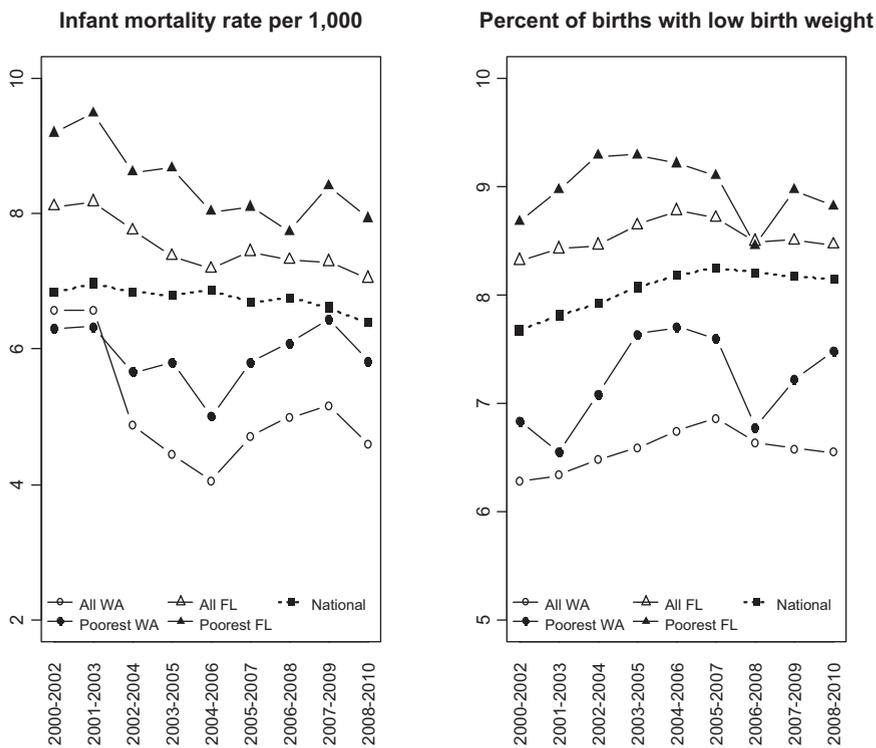
Infant mortality rate per 1,000   **Percent of births with low birth weight**

Figure 2. Changes in LBW and IMR rates by 3-year smoothed averages
IMR, infant mortality rate; LBW, low birth weight

services, which are captured only in the study's total expenditures measure.

Previous research by the authors, using the same sample and much of the same unique data, found that LHD expenditures for MICA services were inversely proportional to local need/demand.[38] The findings presented here suggest that the same LHD expenditures have a relationship with LBW in areas of high poverty in Washington. This raises the concern that jurisdictions where one may see the greatest benefits of LHD investments on population birth outcomes may be most likely to see those services reduced or eliminated.[38]

Indeed, where somewhat less was spent on average for MICA services in poor Washington jurisdictions relative to other jurisdictions in this study, these same impoverished jurisdictions demonstrated strong population-wide impact from their investment—an impact that could be undermined as program funding is reduced and often outside of decision-making authority of an LHD.

Study findings mirror recent research demonstrating beneficial relationships between MCH expenditures by LHDs in California and LBW among marginalized populations[50] and between an LHD's MCH services and reductions in mortality disparities.[2] Together, these studies underscore the need to develop data systems and a robust

research infrastructure capable of monitoring outcomes related to shifts in public health system investments, particularly as community systems of health service delivery change further under the Affordable Care Act.

The central role of public health agencies in the monitoring and assurance of effective health service delivery[1,11] makes it particularly important to establish these data systems and to advocate for MCH investments when millions of Americans are newly able to access preventive services care with insurance expansions through the Affordable Care Act.

Recent landmark studies[32,33] established empirical links between total LHD expenditures and overall mortality rates, and then racial disparities in mortality. Studies like these dramatically advanced public health systems research but were restricted by data limitations to examining high-level, distal mortality outcomes and total LHD expenditures. The more detailed, annual, service-specific expenditure data used in this study allowed for unique examinations of specific services and a proximal, direct outcome. These data were made possible through PBRN practice partnerships that facilitated the acquisition of data, data integrity, and interpretation of findings.

Limitations

These findings are limited by inclusion of just two U.S. states. The study sample, however, included a novel longitudinal data set with a large number of LHD observations and state-level differences taken into account in data analysis and interpretation. Data limitations also restricted examination of the effect of LHD expenditures on disparities in LBW and IMR by race and ethnicity. Cultural factors, policy differences, individual behaviors, and other unobserved place-specific variables may have influenced outcome measures examined here.

To control for unobserved confounders, several instrumental variables were trialed but failed endogeneity tests. Finally, variability in type and quality of MCH services actually delivered by LHDs was not taken into account.

Table 2. Relationship between LHD per-capita expenditures and health outcomes

Expenditure category	All						Poor						Non-poor					
	All states (n=885)		Florida (n=580)		Washington (n=305)		All states (n=290)		Florida (n=191)		Washington (n=99)		All states (n=595)		Florida (n=389)		Washington (n=206)	
	Coeff.	p	Coeff.	p	Coeff.	p	Coeff.	p	Coeff.	p	Coeff.	p	Coeff.	p	Coeff.	p	Coeff.	p
% Low birth weight																		
Total	**−0.012**	**0.028**	−0.006	0.173	−0.044	0.199	−0.011	0.069	−0.002	0.671	**−0.158**	**0.000**	**−0.011**	**0.047**	−0.009	0.163	0.009	0.595
Combined MCH	**−0.030**	**0.038**	−0.018	0.342	−0.063	0.268	−0.013	0.663	−0.013	0.537	**−0.284**	**0.005**	−0.026	0.149	0.0003	0.989	−0.054	0.152
WIC	−0.024	0.490	−0.007	0.754	−0.027	0.886	−0.029	0.541	0.002	0.934	**−0.667**	**0.007**	−0.060	0.215	−0.033	0.395	−0.058	0.660
MICA	**−0.049**	**0.025**	−0.017	0.496	−0.108	0.191	−0.020	0.653	−0.026	0.355	**−0.474**	**0.016**	−0.024	0.307	0.032	0.333	−0.037	0.257
FP	−0.029	0.431	−0.044	0.352	−0.016	0.868	−0.026	0.637	−0.004	0.913	**−0.600**	**0.000**	−0.028	0.559	−0.052	0.521	−0.044	0.522
Total infant mortality																		
Total	−0.009	0.051	−0.007	0.117	−0.015	0.431	**−0.023**	**0.001**	**−0.027**	**0.000**	**−0.041**	**0.009**	0.002	0.723	0.005	0.477	0.005	0.876
Combined MCH	.0011	0.685	0.0008	0.974	0.091	0.253	−0.039	0.304	−0.054	0.251	0.032	0.676	0.069	0.061	**0.076**	**0.017**	0.227	0.092
WIC	−0.049	0.442	−0.042	0.558	−0.270	0.309	−0.006	0.924	−0.047	0.426	0.133	0.524	−0.051	0.621	0.040	0.686	−0.425	0.339
MICA	0.041	0.452	0.004	0.920	0.180	0.128	−0.060	0.377	−0.029	0.712	−0.002	0.992	**0.148**	**0.029**	0.090	0.055	**0.395**	**0.001**
FP	−0.005	0.903	0.041	0.501	0.030	0.611	−0.090	0.177	−0.100	0.271	0.021	0.845	0.025	0.592	0.161	0.041	−0.072	0.409

Note: Boldface indicates statistical significance. Variables included in all models: year+state+CBSA+alternative service (WIC, MICA [0−3], FP)+LHD executive (clinician/non-clinician)+health care provider per capita (physician)+% black+% Hispanic+Social Disadvantage Index (median household income+% of households receiving public assistance+% of unemployment)+% persons with high school or more+total population+% Medicaid-funded births. Combined MCH, WIC+MICA+FP.

CBSA, Core-Based Statistical Areas; Coeff., coefficient; FP, family planning; LHD, local health department; MCH, maternal/child health; MICA, maternal, infant, child, and adolescent health; WIC, Women, Infants, and Children.

The study's emphasis, however, was on the level of LHD investment in reasonably comparable service packages, rather than specifics of individual services being provided.

Conclusions

The assurance role of the nation's public health systems has been heightened as dramatic changes occur nationally in response to the Affordable Care Act, the budget crisis, and in the allocation of public health and health care investments. These findings indicate that specific LHD investments in MCH can and do have an observed effect on population-level health outcomes for marginalized groups and likely help reduce the costly burden of poor birth outcomes for families and communities. These findings underscore the importance of monitoring impacts of these evolving investments and for ensuring targeted, beneficial investments are not lost but expanded upon across care delivery systems.

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